RPS

Review of 'Evaluation of the climate change impacts of waste incineration in the United Kingdom' by UKWIN

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TABLE OF CONTENTS

1 INTRODUCTION

RPS was commissioned to conduct a review of the report produced by the United Kingdom Without Incineration Network (UKWIN) entitled 'Evaluation of the climate change impacts of waste incineration in the United Kingdom' published in October 2018.

This review has considered the UKWIN report with particular attention to its relevance to impacts of the proposed development at Hightown Quarry.

arc21[1] is procuring residual waste treatment infrastructure to manage residual waste arisings in the arc21 region. The proposed infrastructure is designed to complement existing recycling and composting facilities in Northern Ireland which process material collected by the arc21 councils. The proposals are to develop a Residual Waste Treatment Facility incorporating a Mechanical Biological Treatment (MBT) facility, an Energy from Waste (EfW) Thermal Treatment facility, an Incinerator Bottom Ash (IBA) Treatment facility, a Refuse Derived Fuel (RDF) Bale Storage building, and Administration/Visitor Centre at the Hightown Quarry on the Boghill Road, Mallusk, Co Antrim.

UKWIN is a campaigning organisation that exists to oppose incineration of waste. Its report has been authored by UKWIN directors and must be understood in that context, i.e. as a campaigning document produced to justify a pre-defined conclusion.

The UKWIN report purports to "evaluate" the climate change impacts of waste incineration. It discusses four key areas and therefore we have structured this review to follow each of these areas, as follows:

i. Carbon Dioxide (CO_2) released by waste incineration and financial cost;
ii. Carbon intensity of electricity generated;
iii. Comparing incineration with landfill; and
iv. Recyclability of incineration feedstock.

While the UKWIN report is stated to be UK-wide, a number of aspects are largely England-focused; therefore RPS has also endeavoured to test certain assumptions at a regional (Northern Ireland) level. These points include current waste management issues, waste composition and electricity generation in Northern Ireland.

The UKWIN document only focusses on climate change impacts of waste management and does not discuss the other environmental effects of different waste treatment options. Undoubtedly, greenhouse gas (GHG) emissions are not the only important factor that should be taken into consideration when considering incineration of waste. The lack of this context in the UKWIN report means that its conclusions opposing energy-from-waste are based on a flawed evaluation of only one environmental impact, without acknowledging other important and relevant issues.

[1] arc21 is the umbrella waste management group for six councils in the east of Northern Ireland and is the procuring authority for the residual waste treatment infrastructure.

2 CO_2 RELEASED BY WASTE INCINERATION

The UKWIN document states repeatedly that combusting waste directly releases greenhouse gas (GHG) emissions. However, so too does almost any human activity, including most forms of waste management, conventional energy generation and a long list of other activities including transport and agriculture. The failure to acknowledge these equally indisputable facts emphasises the approach of the UKWIN document as promoting a single aspect assessment consistent with the Network's publicly expressed aims. This inevitably undermines the objectivity and reliability of the material and its conclusions.

As a result of this approach, quoting only the direct GHG figures as UKWIN does as its first 'key findings' on page 1 inevitably misses the point. The objective evaluative question is: ***what is the balance (or net effect) of GHG emissions from the proposals compared to what would happen otherwise?***

In this case the residual municipal solid waste exists and is required to be managed sustainably. And there is a demand for electricity, which the proposed facility can generate. The alternatives cause GHG emissions of their own, which must not be ignored nor considered in isolation.

Using this objective basis of assessment, the net effect of the EfW facility proposal can be fairly considered. The UKWIN document 'Key Findings' artificially separates these factors.

2.1 COST OF CARBON

UKWIN's claim about the financial 'cost to society' of fossil carbon released by EfW relies on figures presented as a cost of harm caused (i.e. as being what is called the social cost of carbon) whereas in fact a carbon price representative of a marginal abatement cost has been used.

This marginal abatement cost represents the cost of actions to offset an increase in emissions, i.e. by making reductions elsewhere in the economy. The difference between this and the social cost of carbon formerly used in policy appraisal (but now deprecated) is explained in the Treasury guidance[2] accompanying the price figures used by UKWIN.

The GHG emissions from the Hightown Quarry development are not a net addition but rather are themselves an abatement action because they reduce emissions from landfill and conventional power generation. The UKWIN approach results in double-counting. It makes no sense to apply the marginal abatement cost of carbon to the gross total as UKWIN has done, nor to present the resulting over-inflated figure as a social cost of carbon.

The result of this approach is misleading, with the wrong criteria and assumptions used to arrive at an unsustainable and illogical conclusion.

[2] https://www.gov.uk/government/collections/carbon-valuation

3 CARBON INTENSITY OF ELECTRICITY GENERATED

The UKWIN document compares the environmental impacts of different forms of energy generation by comparing the 'emissions intensity' of the energy generated, gCO_2/kWh, for energy generating technologies of onshore wind, solar panels, combined cycle gas turbine, and energy-from-waste (EfW).

It is wrong to compare the carbon intensity of an EfW facility with another power generator only on the basis of electricity produced. A wind turbine or a gas power station does not prevent waste from going to landfill disposal.

The proper comparison must include the whole proposal, not separately compare an EfW facility with a power station or an EfW facility with landfill disposal and ignore the combined benefits. Such an approach is plainly designed to achieve a skewed assessment and overlooks the primary purpose of the incineration process, which is to manage residual waste as an alternative to mixed and biodegradable waste being put to landfill for disposal. An additional and beneficial effect from this management route is by recovering energy to generate heat and power from the feedstock the process sits higher on the internationally recognised waste hierarchy.

It should also be noted that the marginal emissions factor for displaced electricity generation used by UKWIN is a future projection published by BEIS that is derived from a (UK-average) target value for the carbon intensity of electricity in the future to meet climate goals in 2050[3]. It is not a guaranteed figure or necessarily representative of marginal sources in a particular market.

Relevant regional factors not considered

Northern Ireland, despite rapidly growing renewable capacity, has had a slightly increasing carbon intensity of electricity generation between 2010 and 2015[4] (in contrast with the steep fall for the UK overall) with a significant reliance on the gas, coal and oil fired power stations at Kilroot, Ballylumford and Coolkeeragh. Furthermore, for the purposes of compliance with the Industrial Emissions Directive (IED), some plants require limited running hours to meet requirements and may need to shut by 2023[5]. In this context, with the potential closure of Kilroot and Ballylumford coal-fired units and the resulting need for capacity from other inter-connection and generation sources, it is not clear that the low BEIS UK-average future marginal factor is representative of the effect of providing additional baseload generation capacity in Northern Ireland in the near future, where the marginal emissions displaced may be considered to be considerably higher.

[3] BEIS's projections are based on an interpolation from 2010's assumed marginal generator (a combined cycle gas turbine [CCGT] power station) to a modelled energy mix in 2030 consistent with energy and climate policy and predicted demand reduction scenarios by that point. A grid-average emissions factor is projected by BEIS for 2040 and the marginal factor is assumed to converge with it by that date, interpolated between 2030 and 2040; both factors are then interpolated from 2040 to a national goal for carbon intensity of electricity generation in 2050.

[4] The latest figure available: DAERA and NISRA, 2017. Northern Ireland Carbon Intensity Indicators, Section 1.1. https://www.daera-ni.gov.uk/sites/default/files/publications/daera/northern-ireland-carbon-intensity-indicators-2017.XLSX

[5] EirGrid, All-Island Generation Capacity Statement 2017-2026

4 COMPARING INCINERATION WITH LANDFILL

The UKWIN document states that the climate change impacts of waste incineration can be compared with those associated with sending the same waste, untreated, directly to landfill and implies that landfill is carbon negative and therefore a preferable solution to EfW. This is a flawed approach for a number of reasons:

v. due to the unreasoned assumptions used in calculations;
vi. as the wider environmental effects of landfill are not considered; and
vii. because this conflicts with the waste management hierarchy, strongly established in national policy and international conventions.

When it comes to the asserted comparison with landfill, UKWIN has drawn heavily from the approach and data in a study by Defra published in 2014[6] and cites the study in footnotes. However, UKWIN comes to a different conclusion, presenting figures that suggest landfilling waste causes far less CO_2e to be emitted per tonne of waste than EfW. This is a reversal of the Defra report conclusions[7], and is clearly a matter for concern in considering the weight to be attached to the UKWIN material.

The Defra report is a balanced study, carefully considering the various parameters and uncertainties to which carbon calculations are highly sensitive and looking at the combination of resulting scenarios. It shows in Tables 17-19 that a modern EfW with good efficiency commissioned now or in the near future would have carbon savings compared to landfill in the majority of scenarios. Even in the more pessimistic scenario, the difference would be small: less than 0.1 tCO_2e per tonne of waste treated and well within the uncertainties overall. Taking into account potential biogenic carbon sequestration in landfill, which is described in the study as highly uncertain, an EfW could again still perform comparably in climate change terms with landfill (Charts 15 and 16) with an increase in biogenic content of the waste over time (achieved, for example, with more separation and recycling of plastics) or with an efficiency improvement that could be offered by Combined Heat and Power.

By contrast, UKWIN has taken the Defra study data and repeated its calculations while cherry-picking only the assumptions that most favour landfill in a comparison with EfW. This is set out in Section 4.1, below.

Furthermore, in the case of the proposed Residual Waste Treatment Facility at Hightown Quarry, the proposed development not only generates electricity but has several other elements that contribute to carbon savings and are not considered in the UKWIN study:

i. Front-end waste sorting and recycling, with the benefit of reducing virgin material use (e.g. plastics) and increasing the biogenic to fossil carbon ratio in the residual waste fuel, exactly as suggested for good performance in the Defra study;
ii. Processing of the bottom ash and recycling of metals; and
iii. A CHP-ready design with opportunities to supply heat in the future, further improving its

[6] Defra, 2014: Energy recovery for residual waste. A carbon based modelling approach. Ref. WR1910. http://randd.defra.gov.uk/Document.aspx?Document=11918_WR1910Energyrecoveryforresidualwaste-Acarbonbasedmodellingapporach.pdf

[7] And similar conclusions about the positive comparison of EfW with landfill reached by consultancy Eunomia when setting a 2017 emissions performance standard for waste management in London, including considering biogenic carbon sequestration. Eunomia, 2017. Greenhouse Gas Emissions Performance Standard for London's Local Authority Collected Waste – 2017 Update. https://www.london.gov.uk/sites/default/files/gla_eps_update_2017_final.pdf

energy and carbon efficiency.

4.1 ASSUMPTIONS USED IN CALCULATIONS

As appears hereafter, UKWIN has cherry-picked assumptions to make landfilling waste appear beneficial for climate change, specifically the combination of high landfill gas capture rate and high permanent biogenic carbon sequestration.

4.1.1 Landfill gas capture

The report uses a figure at the optimistic end of the range for landfill gas capture rate. It models landfill gas capture at 75% (implying that only 25% is released to the atmosphere) over the entire lifetime of the landfill, including its early filling stages when the landfill cells are not yet capped through to the 100-150 years of its gas-generating phase.

Assuming a lifetime landfill gas capture rate of 75%, which the Defra study describes as "*a likely maximum under current best practice*" that does "*depend on continuing maintenance of the extraction system for decades after the economic incentive has ceased*" (p63 and p64) favours landfill in a comparison with EfW but is not a performance figure that can be effectively monitored or guaranteed.

A further detailed review of waste management in UK landfills published by Golder Associates for Defra in 2014[8] suggested lower rates of lifetime gas capture of around 50-70% were likely (see section 5) and that the CH_4:CO_2 ratio is likely 57:43 rather than 50:50 as assumed by UKWIN, both of which factors would increase the GHG emissions assumed for waste in landfill.

4.1.2 Sequestration of biogenic carbon in landfill

As set out in the UKWIN report, when waste is burned the carbon is converted into CO_2 and released to the atmosphere, but when waste is landfilled some of the carbon is not immediately released and can be considered to be sequestered, i.e. semi-permanently stored underground in a carbon sink.

The UKWIN document has assumed in the 'base case' scenario that 53% of biogenic carbon is permanently sequestered in a landfill. This is described in the Defra report as "*a very high level of sequestration (around 50%) which could be considered to be an upper limit*" (p58) and a factor that greatly increases the uncertainty of the analysis. This assumption very much favours landfill but is not supported by robust information – as acknowledged in the Defra study. As a result, it would be irresponsible to rely on this document and its conclusions to overturn the waste hierarchy, in which landfill disposal of waste is the least favoured option.

4.1.3 Methane emissions and recycling

There are further points omitted in the UKWIN document that gives a misleading picture of waste management and GHG emissions.

[8] Gregory, R. *et al*., 2014. Review of Landfill Methane Emissions Modelling. Golder Associates, for Defra. http://randd.defra.gov.uk/Document.aspx?Document=12439_WR1908ReviewofMethaneEmissionsModelling.pdf

The explanatory box on page 6 details how carbon is converted to CO_2 when released by combustion but omits to explain that under the anaerobic decomposition conditions in landfill, more than 50% is actually converted to methane (CH_4).

Methane has a much higher global warming potential (GWP) than carbon dioxide, around 28 times higher over a 100-year period and 84 times higher over the first 20 years[90] (the most critical period, given the pressing need to mitigate temperature rises that are locked in by current and near future emissions).

The document does not account for the fact that combusting waste in EfW, rather than burying in landfill, means that metals (which were mixed in with the waste and hence difficult to separate, clean and recycle) are left behind when it is burned and can be extracted from the bottom ash and recycled. Due to the high carbon intensity of producing virgin metals, this recycling is a significant benefit but is not reported in the UKWIN calculations.

The biogenic carbon sequestration in landfill suggested by UKWIN is primarily from the paper, card, wood and food fractions of waste: but paper and carbon especially can be recycled rather than buried, again with carbon benefits due to avoiding producing them anew.

4.1.4 Wider environmental effects of landfill

The wider environmental effects from legal landfill have not been mentioned in the UKWIN report but must not be overlooked. Depending on the nature of the landfill site, these may include:

iv. Leachate generation;
v. Potential surface water contamination;
vi. Potential groundwater contamination;
vii. Potential nuisances on site such as flies, vermin, odour etc; and
viii. The ongoing costs, impacts and need for monitoring associated with the construction and subsequent closure, remediation and aftercare over a long lifetime.

Furthermore when landfilling takes place illegally the effects can be more severe. This factor is an obvious material consideration, expressly referenced in the context of waste management needs in Northern Ireland, and its absence from the UKWIN document again reflects a partisan approach to the subject matter that undermines any reliance on the UKWIN document.

4.1.5 Waste management hierarchy

The UKWIN document implies that, with respect to climate change, the operation of an incinerator would be significantly worse than landfill. This goes against all UK and Northern Ireland waste management policy and in particular the waste hierarchy. It underscores the aims of the document and the fact that it is contrary to national and regional policy.

[9] Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Article 4 of the Waste Framework Directive (WFD) sets out the waste hierarchy, which prioritises waste management options to reduce and manage waste ranking from waste avoidance, as the preferred option followed by resource recovery (which includes incineration with energy recovery or EfW) and as a final option, safe disposal of waste which includes landfill and incineration without energy recovery (Figure 1). The primary purpose of the hierarchy is to minimise adverse environmental effects from waste and to increase resource efficiency in waste management and policy.

The waste hierarchy is fully embedded in waste legislation and policy throughout the UK. Indeed the waste hierarchy is a core principle of the current Northern Ireland waste strategy, *Delivering Resource Efficiency*, published in 2013. The WFD hierarchy was introduced into NI legislation through the Waste Regulations (NI) 2011 and the Department produced guidance on its application under regulation 17(5). Stating that landfill would be more preferable than EfW is in direct contradiction of Northern Ireland legislation and policy.

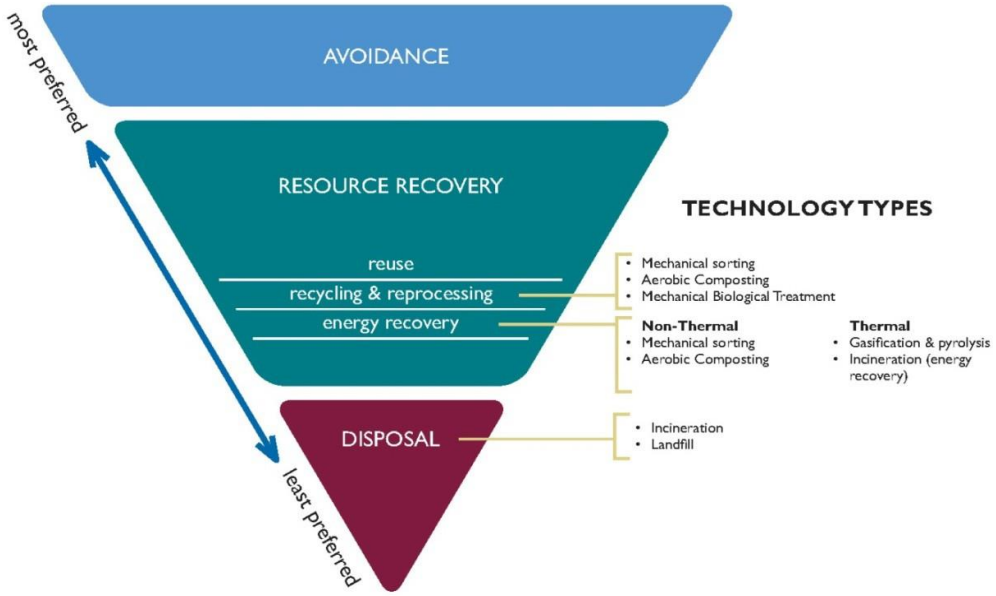

Figure 1 Waste hierarchy

The proposed development of the waste treatment infrastructure at Hightown Quarry is consistent with the internationally recognised waste hierarchy to increase recycling, divert biodegradable waste from landfill and promote environmental awareness of waste issues through education.

5 RECYCLABILITY OF INCINERATOR FEEDSTOCK

In relation to the 'recyclability of incinerator feedstock' we have provided commentary on a number of key issues pertinent to the proposed arc21 infrastructure as follows:

i. Recyclable content of the residual bin;
ii. Front end recycling; and
iii. Incinerator Bottom Ash.

5.1 RECYCLABLE CONTENT OF THE RESIDUAL BIN

UKWIN asserts that '*composition analysis indicates that a clear majority of residual waste is readily recyclable*'. In relation to the recyclability of kerbside residual waste, the UKWIN document states ranges for different areas in England to be ranging from 52% to 58% in terms of their recyclability.

The Department of Agriculture, Environment and Rural Affairs (DAERA) recently completed a composition of household waste collected at the kerbside in Northern Ireland. The results of this Study were published in March 2018 and are consistent with the figures reported for England. The Northern Ireland study estimated that 55% of the contents of the kerbside collected residual bin were made up of waste types that could commonly be recycled at the kerbside.

arc21 has requirements for a suite of integrated facilities that, once developed, will provide beneficial interventions at key levels of the waste hierarchy for municipal solid waste collected by its constituent Councils. arc21, through the development of the proposed waste treatment infrastructure, is seeking to achieve a stepped change not only in minimising the amount of its Council's waste sent directly to landfill but also in:

i. recovering materials (for recycling);
ii. recovering energy (for site heating and electricity production); and
iii. the provision of an educational resource that will help prevent waste being produced in the first place.

Therefore the recyclable content of the residual waste is a consideration for the proposed facility and it is integral to the pre-treatment and front-end recycling process which benefits from having both mechanical and biological treatment to contribute to future recycling performance.

5.2 PRE-TREATMENT AND FRONT END RECYCLING

It is arc21's policy position that both mechanical and biological pre-treatment is required prior to thermal treatment / energy recovery. This pre-treatment of Council collected residual waste via MBT is central to arc21 waste management plan and associated recycling targets. The proposed facilities could also intercept materials for re-use.

arc21's facilities are designed to meet councils' requirements. A wide spectrum of raw waste (multiple waste codes) can be accepted and subject to pre-treatment to remove plastics, card and

paper as well as metals. This will result in a lower energy density of fuel and the thermal treatment facility is matched to suit the fuel following biodrying.

The arc21 Councils are investing circa £60m in a MBT plant to specifically maximise the recycling capability from residual waste. The pre-treatment aspect of the proposed infrastructure will be designed to extract recyclable materials that have not been presented by householders for recycling at the kerbside. This means that material suitable for the recycling market will either be presented at the kerbside by the householders in their dry mixed recyclables (DMR) bin or removed from the residual stream at the facility prior to it being recovered.

Indeed, the pre-treatment aspect of the proposed infrastructure (The c£60 million investment in a mechanical biological treatment facility), will be designed to extract recyclable materials that have not been presented separately by householders in arc21 councils for recycling at the kerbside. In summary, this means that paper, card, plastics and metals material suitable for the recycling market will either be captured either as presented at the kerbside or recovered from the residual waste stream prior to it being subject to thermal treatment and energy recovery.

arc21 has constrained the capacity of the treatment facilities so as to not restrict recycling and reuse of materials and there is inherent adaptability as to how installed plant and equipment is configured and operated to maximise recycling opportunities.

5.3 BOTTOM ASH

Combusting waste in EfW rather than burying in landfill allows metals to be extracted from the incinerator bottom ash (IBA) and recycled while also producing an aggregate product which can be used in the construction industry. Due to the high carbon intensity of producing virgin metals and virgin aggregate, this recycling is a significant benefit but is not reported in the UKWIN calculations.

Furthermore, arc21 recognises the need for markets for IBA to be developed in NI as has been seen in other UK areas as the EfW capacity was brought on line. The allowance for appropriate IBA treatment at the site is unique in a NI context. The proposed IBA treatment facility allows for the recovery and recycling of ferrous and non-ferrous metals remaining in the IBA, while also producing an aggregate product known as incinerator bottom ash aggregate (IBAA). In Europe and GB this aggregate product is increasingly being used in applications such as concrete block manufacturing, pipe bedding and road construction.

6 CONCLUSION

UKWIN is an action group opposed to incineration. Its approach is defined by that stance.

As has been demonstrated above, the UKWIN document contains material misinterpretations of data and omits important matters from assessment.

While combusting residual waste does directly release GHG emissions, the document fails to grapple objectively with the key question: ***what is the balance (or net effect) of GHG emissions from the proposals compared to what would happen otherwise?*** The relevant basis for assessment is to compare EfW with current waste management practices *and* with current electricity generation, taken together.

It is irrational for the UKWIN document to try to compare in isolation the carbon intensity of electricity generated by an energy-from-waste facility with a wind turbine: a wind turbine cannot treat and manage waste.

The UKWIN approach in the comparison with landfill is contrary to established evidence and policy including the waste hierarchy that led to the adoption of the Landfill Directive in 1999 across the EU.

A close review of the UKWIN calculations shows that its conclusions, highly favourable to landfill, are due to two crucial assumptions about the effectiveness of capturing landfill gas emissions and about the amount of biogenic carbon that does not decay. UKWIN's calculations are based on the approach and information in a 2014 Defra study, but rather than acknowledging the substantial uncertainties in these two factors as Defra did, UKWIN picks data points described as "a likely maximum" and "an upper limit" to support its case. The conclusions about landfill therefore implicitly assume without evidence that these highly optimistic factors could be monitored and guaranteed for a landfill gas-generating lifetime of up to 150 years.

The UKWIN document has no direct relevance to the specific regional issues material to Northern Ireland.

The proposed development at Hightown Quarry differs from EfWs described in the UKWIN document. The proposed development includes front-end sorting of waste to extract and recycle plastics, card, paper and metals. It also includes a bottom-ash treatment facility from which further metal can be recycled, which is not featured in the UKWIN calculations.

In summary, the UKWIN document is not an objective 'evaluation of the climate change impacts of waste incineration in the United Kingdom' but rather is a partisan collection of arguments and assumptions to support a pre-defined anti-incineration conclusion.